

EXPLANATION OF PLATE IV.

- Fig. 1. *Rana Ansorgii*, p. 107, natural size.  
 Fig. 2. *Arthroleptis xenochirus*, p. 108, natural size.  
 Fig. 2 a. *Arthroleptis xenochirus*, lower aspect of hand,  $\times 4$ .  
 Figs. 3, 3 a. *Arthroleptis parvulus*, p. 109, natural size.  
 Fig. 3 b. *Arthroleptis parvulus*, lower aspect of foot,  $\times 4$ .  
 Fig. 4. *Psammodis Ansorgii*, p. 113, upper and side views of head and anterior part of body, natural size.

XI.—On the Internal Parasites of the Tweed Salmon. By JAMES R. TOSH, M.A., D.Sc., Assistant Professor and Lecturer on Natural History in the University of St. Andrews.

[Plate V.]

SPECIMENS of the parasites mentioned below were collected during the net-fishing season of 1895 at the premises of the Salmon Fishing Company, Berwick-on-Tweed.

The distinctly marine character of the parasitic guests of the salmon is an indication of the nature of its food. Fresh-water parasitic forms are very rare in the salmon, and the fact that they are practically absent in well-grown fishes seems to point to the conclusion that salmon do not feed in the fresh water of a short river like the Tweed except under extraordinary conditions, when a prolonged stay is imposed upon them.

The following is a list of Entozoa observed:—

<i>Ascaris capsularia</i> , Rud.	<i>Echinorhynchus angustatus</i> , Rud.
— <i>acuta</i> , Müll.	<i>Bothriocephalus infundibuliformis</i> , Rud.
— <i>obtusocaudata</i> , Zed.	<i>Tetrarhynchus grossus</i> , Rud.
<i>Distoma varicum</i> , Rud.	— <i>macrobothrius</i> , Rud.
— <i>ocreatum</i> , Rud.	<i>Tetrabothrium minimum</i> . Larva.
— <i>Miescheri</i> , Zschokke.	— sp. Larva.
<i>Echinorhynchus acus</i> , Rud.	<i>Tænia</i> sp. Larva.
— <i>proteus</i> , Westrumb.	

*Ascaris capsularia*, Rud. Entoz. t. ii. i. p. 179.

This form occurs very plentifully encapsuled on the pyloric cæca and mesenteries. The average length is about 26 mm. It is very active when taken out. The usual infection is from 20 to 50 in each fish.

*Ascaris acuta*, Müll. Zool. Dan. vol. iii. p. 53.

This is the parasite that occurs most frequently in the

almon, usually in the stomach, seldom below the pylorus. Many are sexually mature, and if kept in fresh water will often extrude their eggs, which undergo a direct development.

*Ascaris obtusocaudata*, Zed., Rud. Entoz. t. ii. i. p. 177.

Only one specimen was obtained from the stomach. It measures 6 mm. Others may have been overlooked.

*Distoma varicum*, Rud. Entoz. t. ii. i. p. 396.

This well-known form is the most constant parasite of the salmon. It varies in size from 2-3 mm. and occurs as noticeable yellow specks on the walls of the œsophagus and stomach, rarely in the intestine. The colour is from the yellow-brown ova in the uterus. The usual infection is up to 40 or 50.

*Distoma ocreatum*, Rud. Entoz. t. ii. i. p. 397.

Large infections of this species were occasionally found floating in a watery mucus in the stomach above the bend. It was not observed attached to the stomach-walls like the preceding species. It occurs more frequently in the sea-trout than in the salmon, and especially after a diet of herring.

*Distoma Miescheri*, Zschokke, Verhand. naturforsch. Gesell. Basel, viii. Theil, 3 Heft.

A few solitary specimens in the gullet adhering to the mucous membrane. Brown in colour, with stalked ventral sucker, it varies in length from 9-17 mm. The species is described and figured by Prof. Zschokke from the Rhine salmon.

*Echinorhynchus acus*, Rud. Entoz. t. ii. i. p. 278.

*E. acus* was found attached in the lower intestine. The specimens varied in length from 12-31 mm. Not common.

*Echinorhynchus proteus*, Westrumb. De Helm. Acanth. p. 37, no. 66.

*E. proteus* has been described under many names. It occurred in the lower intestine with the proboscis buried up to the neck and with the bulb expanded but out of sight. Length 6-9 mm. Commoner than *E. acus*.

*Echinorhynchus angustatus*, Rud. Entoz. t. ii. i. p. 266.

*E. affinis* is given by Rudolphi as a synonym. My

specimens agreed better with the description of the latter. Found occasionally in smolts and once in a small salmon. Length 7-9 mm. A freshwater form.

*Bothriocephalus infundibuliformis*, Rud. Entoz. t. ii. i. p. 46.

Same as *B. proboscideus*, Rud. This tapeworm, which has a wide distribution among marine fishes, is in appearance the most formidable parasite of the Tweed salmon. It does not seem to be seriously harmful to its host, and is to be found in the largest and best-fed fishes, usually in numbers ranging from 1 to half a dozen. The great infections of from 100 upwards mentioned by Zschokke as occurring in the Rhine salmon have not been observed in the case of the Tweed fishes, but have been noted in the sea-trout of the same river. In one sea-trout as many as 150 specimens, all very young, were counted. The head of the tapeworm is almost invariably attached near the bottom of a pyloric cæcum.

Appended is a table giving the occurrence of this tapeworm as noted in the fishes observed at the Berwick-on-Tweed Salmon Company's Fish House in 1895:—

	Male Grilse.		Female Grilse.		Male Salmon.		Female Salmon.	
	Number examined.	Number containing tapeworms.	Number examined.	Number containing tapeworms.	Number examined.	Number containing tapeworms.	Number examined.	Number containing tapeworms.
March....	..	..	..	..	3	1	12	3
April ....	..	..	..	..	15	10	67	22
May ....	5	..	..	..	23	8	106	34
June ....	8	1	11	3	18	9	79	23
July ....	36	7	20	2	25	9	88	24
August ..	42	5	24	3	13	5	65	22
September.	13	..	7	1	3	..	33	11
October ..	21	4	3	..	34	6	37	4
November.	12	..	4	..	20	5	45	14
	137	17	69	9	154	53	532	157

Of a total of 892 fishes examined 236, or 26·4 per cent., were infected with tapeworm. It would be interesting to know if the falling off about October were at all constant, and, if so, whether the rise in November was connected with a final feast before the dash for the river.

*Tetrarhynchus grossus*, Rud. Synops. pp. 129 & 448, pl. ii. figs. 9 & 10. (Pl. V.)

This form, known to the salmon-fishermen of Berwick-on-Tweed as a "flatty," occurs in the abdominal cavity of both salmon and sea-trout, and is more often dead than alive. The live form is found almost invariably attached by its proboscides to the outside of the lower intestine near the vent. It is cream-coloured and soft, with parallel striæ on the flattened body behind the head. If touched or detached it contracts actively. When preserved the striated part becomes rugose and sometimes almost tuberculated. A preserved specimen sent by the late Dr. Johnston from Berwick-on-Tweed was described and figured by Dr. Baird as *T. rugosus* \*.

If unable to pass to the intestine of another host, *e. g.* shark, where it would most likely become sexual, the worm after some time seems to die, loosens its hold, drifts forward in the body-cavity, and usually becomes embedded in a soft organ, such as the liver. There it is pressed out of shape, becoming often triangular in section or bent on itself. The head retains most of its former bulk, but the body becomes stiff and attenuates. Sometimes specimens are found with the flesh coming away in irregular layers from the body. The surrounding tissue is often affected by this process of degeneration. Specimens in this stage were described and figured by Drummond as *T. solidus* †.

In the accompanying Plate the process of degeneration is illustrated. Fig. 1 is *T. grossus* from a preserved specimen; fig. 2 has a head and body of *T. solidus* and a tail of *T. grossus*, and shows the papilla where the strobila would have budded.

Von Siebold considers his *T. claviger* ‡ to be identical with *T. grossus*, and most likely all the species listed by him on p. 235 (*loc. cit.*) are synonyms; but he places the *T. solidus*

\* Catal. Entoz. Brit. Mus. p. 69, tab. ii. fig. 3.

† Charlesworth's Mag. Nat. Hist. vol. ii. (1838).

‡ Zeitschr. wiss. Zool. Bd. ii.

of Drummond with *T. megacephalus*, which is distinctly separated from *T. grossus* by its tapering proboscides. In the dead form the proboscides are rarely altogether retracted, and they still resemble those of *T. grossus*.

*Tetrarhynchus macrobothrius*, Rud. Synops. pp. 131 & 453.

Length 3-8 mm. Specimens occurred free in the body-cavity, oftenest in the region of the liver and also encysted on the outer wall of the œsophagus. When liberated from cysts they were yellow, almost orange-coloured. Those in the body-cavity were creamy white. *T. megabothrius*, Rud., and *T. appendiculatus*, Rud., may be the same as the species in question.

The larva of *Tetrabothrium minimum* occurred in the mucus of the pyloric cæca.

*Tetrabothrium* sp.

A few larval forms were found in fluid in the rectum—probably more advanced forms of the last species.

*Tenia* sp.

One larva was observed.

The list of parasites of the Tay salmon given by Prof. M'Intosh\* corresponds to the above in its thoroughly marine character.

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#### EXPLANATION OF PLATE V.

- Fig. 1.* *Tetrarhynchus grossus*, Rud. Length 30 mm.  
*Fig. 2.* Ditto. Length 38 mm.  
*Fig. 3.* Ditto. Length 29 mm.  
*Fig. 4.* Ditto. Length 24 mm.  
*Fig. 5.* Ditto. Length 30 mm.

All from spirit-specimens.

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\* Journ. Proc. Linn. Soc. vol. vii. pp. 145-154, 2 woodcuts.